91602
new 82-10

To: Mr. M.A. Machacek
Manager - Engineering
Darlington GS
Design and Construction Branch

ontario hydro
research division

COMPLIMENTARY COPY
Please Credit Ontario Hydro Research if Reproduced in Whole or in Part

INSTRUMENTATION REPORT - DARLINGTON GS TURBO-GENERATOR UNIT 4 STABILITY INSTRUMENTATION REPORT

A.G. Morton

This report describes the instrumentation and reading technique used in the Unit 4 turbo-generator settlement monitoring program at Darlington GS. Similar installations have been successfully completed on Units 1 and 2. Units 3 and 4 contain less instrumentation than Units 1 and 2. The datum readings for Unit 4 are presented in this report. An addendum will be prepared as the readings are obtained during machine erection and commissioning. Spring support gap stations and support column elevation stations were installed at the joint request of operations and construction personnel on Units 3 and 4/1/. The datum readings reported here are intended as reference readings for future use during maintenance shutdown, etc.

INTRODUCTION

Four single shaft 850 MW turbo-generators are being installed at Darlington GS. Due to the size and complexity of the turbo-generator foundations, it was considered that information on their stability performance should be obtained. Units 1 and 2 were completely instrumented as described in/1/.

A lesser amount of instrumentation was planned for Unit 4, consisting of 12 combination stations on the turbine table (elevation 115.0 m) for horizontal alignment, vertical settlement and dynamic velocity measurements and 12 spring gap stations. In addition to the planned instruments, settlement stations were placed at elevation 101.0 m on the support columns for Units 3 and 4. Installation of these instruments and initial readings in the table in an unloaded condition are presented.

job	file	date	report no.
43-137-153	843.12	August 31, 1989	89-210-K

LEGAL NOTICE

This report was prepared by Ontario Hydro and, while effort has been made to assure the accuracy and applicability of the material contained herein, neither Ontario Hydro nor any person acting on its behalf:

(a) makes any warranty, express or implied with respect to the use of any information, apparatus, method or process disclosed in this report or that such use may not infringe privately owned rights; or

(b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

TURBINE TABLE SETTLEMENT STATIONS

Twelve multi-purpose stations are located on top of the turbo-generator support table at elevation 115.0 m (operating floor). Figure 1 shows how these stations are constructed and the location of these stations is shown in Figure 2.

(a) The purpose of these stations is to measure differential movements of the machine floor in both the vertical and horizontal directions as well as provide a reference point for monitoring vibration levels of the structure. The specially designed reference stations were installed opposite the centreline of each bearing of the machine in two straight lines, one on each side of the turbo-generator. Each station is provided with a protective cover. See Figure 1 for an illustration of these stations.

(b) The elevation of each of the twelve reference stations is obtained to an accuracy of 0.1 mm (0.004 in). The 2.0 meter invar levelling rod, with a flat seat, is held on the rounded top of the reference station. Using the Wild-N3 precise level and standard procedures for precision levelling, measurements on the complete traverse of 12 reference stations are made. An accuracy of +/- 0.15 mm for any station relative to the datum station, under favourable working conditions, is achievable. Any vibration or heat produced when the unit is running decreases this accuracy. The initial datum readings are tabulated in Table I. These elevation readings are given relative to table station T-1A, located in the southwest corner of the table (see Figure 2).

TURBINE TABLE ALIGNMENT STATIONS

The same twelve reference stations described above are used to take the alignment measurements. For location of these stations, see Figure 2.

(a) The purpose of these measurements is to determine the horizontal displacements of the machine floor relative to an optical line of sight. A Wild T-2 theodolite and targets with optical plumbs were used to measure small horizontal displacements (offsets) of the alignment stations from an optical line of sight. The line of sight is referenced to the stations at each end of the turbine table.

(b) The following procedure is used to take the measurements. The T-2 is placed centrally by optical plumbing on the alignment target cemented on the designated area of the reference station at one end of the unit (see Figure 1). A fixed target is similarly placed over the alignment target on the reference station at the other end of the unit, establishing an optical line of sight. Once the instruments are plumbed over their reference stations they are not moved during the series of measurements. A movable target, which carried a modified precision vernier caliper scale (for adjusting the target at right angles to the line of sight), is similarly set up over each of the four "in between" stations and their offset measurements are taken. With extreme care in setting the targets and adjusting the plane of the scale at right angles to the line of sight, the horizontal displacements (offset), to the left or right of

the line of sight, can be measured to an estimated accuracy of +/- 0.25 mm. Repeatability error due to the setting up of the instruments relative to the reference target introduces an estimated additional +/- 0.25 mm into the reading accuracy of each measurement. Any heat or vibration produced when the unit is running decreases this accuracy. The movable target vernier is calibrated in inches. These alignment readings are taken on both sides of the turbine table. (Initial datum readings are presented in Table II.)

SUPPORT COLUMN ELEVATION AND SPRING SUPPORT GAP MEASUREMENTS

A joint construction, operations request resulted in the installation of spring support gap stations and support column stations on Units 3 and 4. It was felt that a reference measurement of these parameters might be useful in future maintenance shutdown endeavours. Tables III and V present the reference support column measurements for Units 3 and 4. Reference spring support gap measurements are presented in Tables IV and VI. Unit 4 measurements were made in the bare table situation while Unit 3 was partially constructed at the time of installation of the measurement devices.

SUMMARY

The instrumentation program for Unit 4 has been tailored to obtain the vertical and horizontal movement in the machine table.

The initial datum readings for Unit 4 have been taken and are recorded in this report. An addendum will report any subsequent readings when they are taken.

Approved by:

for T.W. Klym
Manager
Civil Research Department

Prepared by:

A.G. Morton
Technician
Soil Sciences Section

Reviewed by:

C.B.H. Cragg
Senior Engineer
Soil Sciences Section

DSF:LM

REFERENCES

1. Fraser, D.S. "Installation Report - Darlington GS Turbo-generators Units 1 and 2 Stability Instrumentation". Research Division Report No 87-175-K, August 1987.

TABLE I

Differential Vertical Elevations
Darlington GS Unit 4
Elevation 115.0 m (Machine Table Stations)

Datum Readings (Bare Table)
Date: July 13, 1989

Station	Elevation (mm)
T-1	11.22
T-1A	0.00
T-2	20.24
T-2A	15.18
T-3	-2.21
T-3A	19.63
T-4	14.64
T-4A	26.03
T-5	13.46
T-5A	15.11
T-6	-3.84
T-6A	13.56

TABLE II

Differential Horizontal Movements
Turbo-Generator Foundation
Darlington GS Unit No 4

Datum Readings (Bare Table)
Date: July 13, 1989

Station	Side	Average Reading (mm)
T-1	North	Theodolite Station
T-2		35.890
T-3		76.200
T-4		62.052
T-5		124.892
T-6		TARGET
T-1A	South	Theodolite Station
T-2A		80.874
T-3A		108.356
T-4A		89.992
T-5A		115.418
T-6A		TARGET

TABLE III

Differential Vertical Elevations
Darlington GS Unit 4
Elevation 101.0 m (Support Column Stations)

Datum Readings (Bare Table)
Date: July 13, 1989

Station	Elevation (mm) (Relative to Station C-1A)
C-1	-15.61
C-1A	0.00
C-2	-10.64
C-2A	12.12
C-3	-19.49
C-3A	-21.83
C-4	-21.88
C-4A	30.99
C-5	-18.40
C-5A	-10.79
C-6	3.95
C-6A	-25.87

TABLE IV

SPRING SUPPORT GAP MEASUREMENTS
DARLINGTON GS UNIT 4

DATUM READINGS (Bare Table)
DATE: July 13, 1989

Station	Reading (mm)
G-1	776.81
G-1A	768.77
G-2	829.00
G-2A	822.23
G-3	916.40
G-3A	912.90
G-4	914.81
G-4A	916.13
G-5	923.75
G-5A	921.55
G-6	918.96
G-6A	926.31

TABLE V

Differential Vertical Elevations
Darlington GS Unit 3
Elevation 101.0 m (Support Column Stations)

Datum Readings (Partially Loaded Table)
Date: July 13, 1989

Station	Elevation (mm) (Relative to Station C-1A)
C-1	-16.04
C-1A	0.00
C-2	- 1.69
C-2A	6.56
C-3	-10.75
C-3A	10.76
C-4	- 9.00
C-4A	- 0.43
C-5	0.45
C-5A	-17.53
C-6	9.29
C-6A	12.18

TABLE VI

SPRING SUPPORT GAP MEASUREMENTS
DARLINGTON GS UNIT 3

DATUM READINGS (Partially Loaded Table)
DATE: July 13, 1989

Station	Reading (mm)
G-1	777.38
G-1A	779.19
G-2	816.80
G-2A	825.41
G-3	920.93
G-3A	916.47
G-4	921.10
G-4A	916.57
G-5	924.85
G-5A	923.45
G-6	919.53
G-6A	926.08

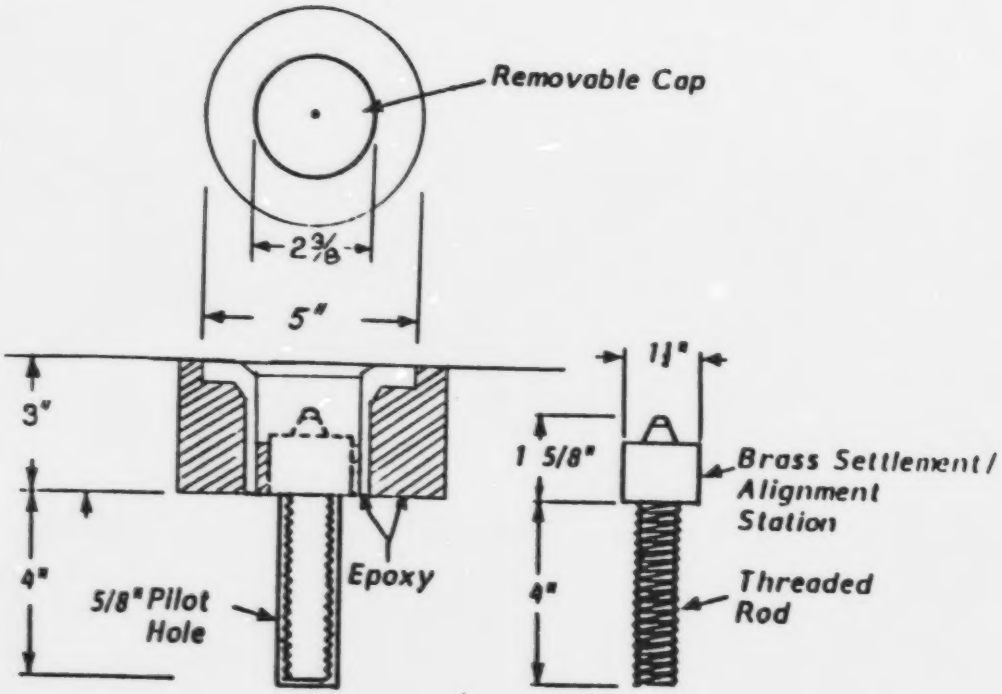

FIGURE 1

SETTLEMENT/ALIGNMENT STATIONS

(revised 08-88)

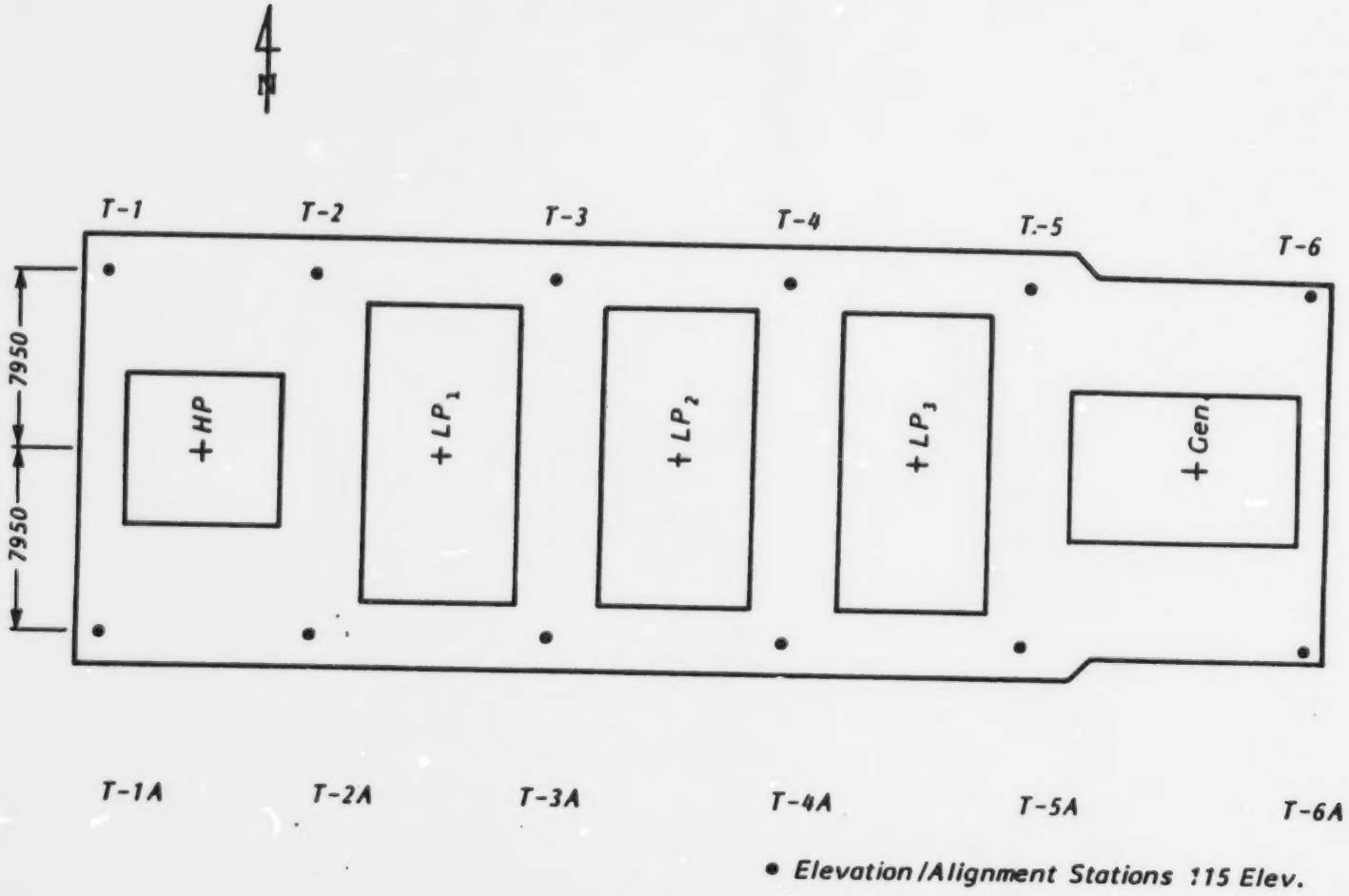

FIGURE 2

DARLINGTON GS UNIT 4
ELEVATION/ALIGNMENT STATIONS - 115 ELEV